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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 : D21D 5/02 — A1

(11) International Publication Number: WO 93/23609

(43) International Publication Date: 25 November 1993 (25.11.93)

(21) International Application Number: PCT/FI93/00213

(22) International Filing Date: 19 May 1993 (19.05.93)

(30) Priority data:
922284 19 May 1992 (19.05.92) FI

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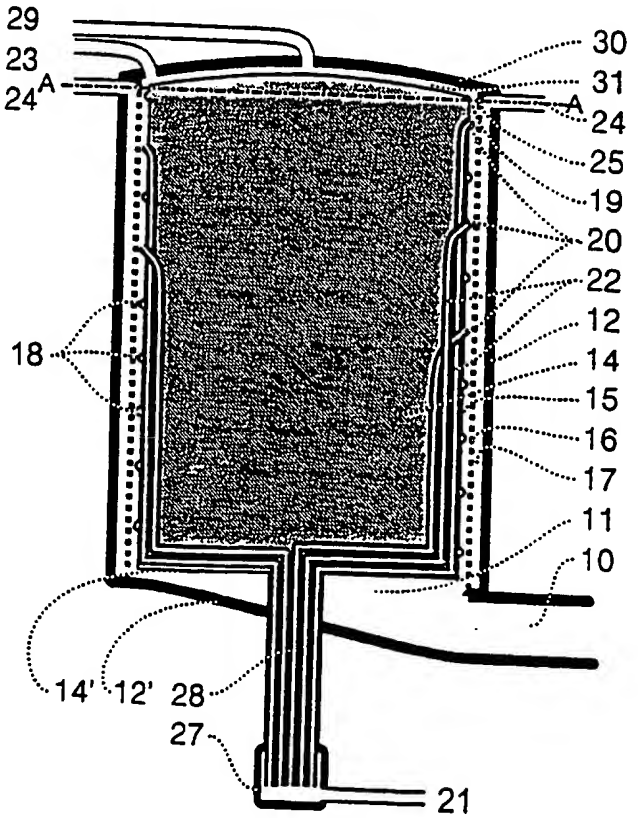
(81) Designated States: AT, AU, BB, BG, BR, CA, CH, CZ, DE, DK, ES, FI, GB, HU, JP, KP, KR, KZ, LK, LU, MG, MN, MW, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SK, UA, US, VN, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(54) Title: PROCESS AND APPARATUS FOR THE SCREENING OF A PULP SUSPENSION

(57) Abstract

The invention relates to a pressurized screen for the screening of fibre suspensions, having a screen plate cylinder (16) surrounded by a housing (12) and containing a rotor (14). In said rotor there are dilution water pipes (22) directly connected to dilution water nozzles (20) discharging close to the screening surface of said screen plate cylinder (16) and rotating with said rotor (14). The invention also relates to a process for cleaning a fibre suspension in a pressurized screen, where the fibre suspension is diluted during the screening process with dilution water being fed directly from outside said housing (12) to said screening surface. The screen according to the invention is particularly favorable for use in the short circulation of a papermaking machine.



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Process and apparatus for the screening of a pulp suspension.

The present invention relates to a pressurized screen and a process for screening a pulp suspension in a pressurized screen. The invention also relates to the use of said screen in a paper machine short circulation. The invention relates principally to the removal of impurities from fibre slurries used in the pulp and paper industries. The invention presents a further development of commonly used pressurized screens, by which the loss of good material together with rejects is minimized so that the cleaning process becomes more efficient, compact and energy efficient.

In known screens, presented among others in Patent publication US 3,363,759, a fibre slurry is fed into a space, limited at least in one direction by a screen plate, through which the fibre suspension is forced, and which prevents the passage of fibre bundles and other bigger particles together with the accepted fraction, i.e. the accept, from passing through the screen. Due to the mechanism of screening, also a part of the good fibres stop at the screen plate, forming a fibre mat which gradually thickens and prevents the flow through the screen. According to the above mentioned US Patent the fibres collecting at the screen plate are brought back into the suspension by means of turbulence generating bumps in the surface of a rotor.

The temporary hold of fibres at the screen plate also makes the liquid component of the suspension pass the screen faster than the fibres, which causes the suspension to be screened to become gradually more concentrated in the screening zone. This again gradually decreases the functionality of the screening, until the screening has to be interrupted in order to prevent excessive concentration and a resulting clogging of the screen.

Removing the fraction not passing the screen, i.e. the reject, from the screen, also requires a sufficient volume flow so that the flow speed in reject pipes can be kept sufficiently high, and the separation of solids and consequent clogging of the piping can be avoided.

Due to these phenomena a significant portion, typically 5 to 30%, of the good fibres screened are rejected when screening in a conventional screen. In order

to recover these fibres, the reject is rediluted and cleaned in a second cleaning stage in an other screen, the reject of which can be cleaned in a third stage and so on. As a last cleaning stage, normally, an open screen, from which the reject can be removed at a high consistency is used.

The multistage screening is obviously disadvantageous regarding need for space, investment, energy consumption, cleanliness and also otherwise regarding controllability.

In previously used open screens it was common practice to dilute the screening goods in the screening zone, and also for pressurized screens internal dilution has been attempted, and the difficulties resulting, resolved in various ways. US Patent 3,437,204 avoids stratifications and poor mixing, when diluting through a rotor, by feeding dilution water through a screen plate. EP Patent Application 0233517, aiming at the washing of recycled wastepaper also introduces water through an opening in the screen plate. Both these solutions lead to consistency differences at the accept side, which would require further equalizing before use in a paper machine. There are also other drawbacks, such as the fast draining of dilution water and consequently an excessive need for such water, complicated screen maintenance, and others.

FI Patent 70059 and FI Patent 70614 present solutions, whereby dilution water is fed into a screening zone through the screen rotor. Both these solutions entail complicated mechanisms for the distribution of dilution water, and the risk for build up of dirt and slime. Such problems are mentioned in the disclosure of US Patent 3,437,204, and are obvious if operated with paper machine backwater. These screens are thus not suited for the use in a paper machine wet end.

The traditional papermachine wet end involves huge volumes of circulating backwater and many feedback loops for secondary cleaning and screening stages. Copending Patent Application FI 922285 by the present inventor provides a novel solution to the problems regarding controllability and cleanliness in a papermaking process. Said solution essentially eliminates the huge water volumes and the feedbacks in a paper machine short circulation.

The object of the present invention is to avoid the limitations set by the prior art by feeding dilution water as small partial flows through the rotor of a

pressurized screen, so that the kinetic energy of the water is utilized for the generation of useful turbulence and the resuspension of concentrated fibre layer. An object of the invention is also to avoid the previous problem of clogged channels and nozzles.

Generally the object of the present invention is to produce a screening process involving a small volume and avoiding feedback loops. Said screening process is especially useful in a self cleaning papermaking process.

The invention provides a process, whereby the thickening of a fibre suspension to be screened is prevented by continuous dilution and which makes an essentially total separation of good fibres from the reject before said reject is extracted from the screen. This makes possible the efficient cleaning of the fibre suspension in one stage and produces a simpler and more advantageous process.

The particular features of the invention appear from the appended claims and the following description. Thus, the invention relates to a pressurized screen for the screening of a fibre suspension comprising a screen housing outside and a rotor inside a perforated screen plate cylinder, whereby a screening zone retaining the reject is formed between said screen plate cylinder and said rotor and an accept chamber receiving the accept is formed between said screen plate cylinder and said screen housing said rotor having means for the feeding of dilution water into said fibre suspension. A characteristic feature of a screen according to the present invention resides in that said rotor comprises a dilution water piping leading directly from outside said housing to multiple dilution water nozzles opening close to the screening surface of said screen plate cylinder and rotating with said rotor.

There are numerous water dilution pipes leading in said rotor directly from outside said housing or from a common pipe extending in said rotor to said nozzles. There are preferably more than five dilution pipes i order to provide dilution exactly at the points where it is required. The number of dilution pipes may be very large, over 10 and up to 100.

The pipes should be designed to provide a continuous and relatively high speed of flow in each of said pipes in order to prevent biological activity and buildup of deposits in the pipes.

According to the process of the present invention for screening a fibre suspension in a pressurized screen said suspension is diluted during the screening process by water fed through a rotor rotating inside a screen plate cylinder. Said dilution water is led from outside said screen directly via numerous pipes in said rotor to the screening zone of said screen as locally directed flows generating turbulence close to the screening surface of said screen.

The screen according to the invention is particularly well suited for use in a paper machine short circulation immediately before the paper machine headbox, in a process wherein backwater is recycled as air free flows directly from the paper machine forming fabric to the dilution water nozzles of the pressurized screen.

In the following description the invention is explained in more detail making reference to following drawings, wherein:

Fig 1 shows a preferred embodiment of a screen according to the invention as a schematic section.

Fig 2 shows a section of the screen represented in Fig 1 along line A-A.

Fig 3 shows another embodiment of the screen according to the invention.

Fig 4 shows a papermachine wet end, in which a pressurized screen according to the invention is used.

Fig 1 represents in general a pressurized screen 10 according to the invention, which has an essentially cylindrical housing 12 and situated therein an essentially cylindrical perforated screen plate cylinder 16, the holes of which are designed to allow passage of the accept of a fibre suspension to be screened. Inside the screen plate cylinder 16 at a distance from its inner surface is a rotor 14 coaxial with the same. At the inlet end of the screen, there is a fibre suspension inlet 10 and an inject chamber 11, limited by the bottom 12' of housing 12 and correspondingly of the bottom 14' of rotor 14. Between the screen plate cylinder 16 and the mantle of rotor 14 a screening zone 15 is formed. Correspondingly an accept chamber 17 forms outside screen plate cylinder 16, between said cylinder 16 and the mantle of housing 12.

In a favorable embodiment of the invention the mantle of housing 12 is slightly conical and equally the mantle of rotor 14 is slightly conical, so that their diameters are smaller at the inlet end than at the outlet end. The screen plate cylinder 16 between them is however essentially cylindrical. Hereby the section of the screening zone 15 decreases and correspondingly the section of accept chamber 17 increases from the inlet end towards the outlet end, permitting the axial flow speed of the fibre suspension to be screened and of the accept to remain essentially constant and sufficiently high throughout the screen, in spite of the flow of accepts from the screening zone to the accept chamber.

Opposite to the inject chamber 11 an accept outlet pipe or pipes 24 join the accept chamber 17. In a preferred embodiment of the invention there are multiple accept outlet pipes, so that the accept can be conducted to a paper machine headbox following the screen as multiple separate flows, which distribute the stock uniformly into the headbox.

A separation ring 25, which is an unperforated prolongation of the screen plate cylinder 16 or a separate member of the housing 12 shields the outlets 24 from the direct influence of pressure pulses resulting from turbulence generating bumps 18 or the rotor 14. In the drawings the outlets 24 of Fig 1 are positioned opposite to the inlet chamber 11. However, it is obvious that the outlets can also be positioned at other parts of the mantle of housing 12, favorably close to the inlet chamber 11, and that in this case the favorable conicity of housing 12 would be reversed so that the largest section of accept chamber 17 would be closest to the outlet pipe or pipes 24.

At the end of the screening zone 15 begins a reject zone 19, limited by the separation ring 25 and the rotor mantle. Here where the reject is further diluted by injection of water through reject dilution pipe 29 and extracted through reject discharge outlet 23. In the shown embodiment reject dilution water is brought through an inlet 29 through a top cover 30 of housing 12 and further into a distribution space formed between the top cover 30 and the top 31 rotor 14, said top 31 favorably being equipped with grooves or ribs for facilitating the distribution of dilution water to the reject zone.

In an alternative embodiment of the invention, (not shown), the reject dilution

water is brought to reject dilution nozzles in the reject zone, through a separate piping in the rotor in a similar manner as the dilution water for dilution in the screening zone.

Close to the reject zone 19 the fibre suspension to be screened contains a relatively higher proportion of reject material. It may therefore be appropriate to graduate the perforation of the screen plate cylinder so, that the perforation is finer at the reject end of the screening zone.
The shaft 28 of rotor 14 contains a number of dilution water pipes 22, which lead into rotor 14 ending at dilution water nozzles 20 close to the screen plate cylinder 16. There are numerous nozzles 20 along the surface of the rotor 14. The distance between the rotor 14 and the screen plate cylinder 16 is relatively small, so that the nozzles open relatively close to the surface of the screen plate cylinder 16.

During operation, a fibre suspension is fed through the inlet pipe 10 to inject chamber 11, from where it passes into the screening zone 15. The feeding pressure and centrifugal force cause a flow through the screen plate cylinder 16 to the accept chamber 17. An acceptable fine fraction flows with the flow whereas the screen plate cylinder 16 retains the coarse fraction to be separated and also a statistical part of the acceptable fibres.

Because the screen plate retains the material to be separated as well as a part of the acceptable fibres, relatively more water than solids pass the screen plate cylinder 16. Therefore the solids content tends to increase in the screening zone 15. The increase in solids content is countered by feeding dilution water into the screening zone. According to the invention the dilution water is fed through the pipes 22 going directly through the rotor 14 to nozzles 20 at the surface of the rotor. According to the invention the dilution water is fed so, that the discharge of water through nozzles 20 cause local spots of turbulence, which act on the fibre material collected on screen plate cylinder 16, detaching the layer of fibres and reject which has gathered on the screen plate and impedes the flow.

The number of nozzles 20 should be sufficiently big, typically 5 to 100, favorably 20 to 50, so that essentially all the screening surface, subject to thickening can be swept by the dilution water jets, and so that the dilution can be split into parts, sufficiently small for not causing significant variation in

accept consistency. The thickening of inject stock progresses gradually, and normally does not constitute a problem at the beginning of the screening process. The dilution nozzles, therefore, can favorably be concentrated to the second half or last third of the screening zone.

The flow can also be promoted by causing turbulence and counter flow pressure pulses at the screening surface by means of mechanical turbulence generators 18. The turbulence generators 18 can be for example bumps in the rotor surface or separate foils.

The dilution water is favorably fed into dilution water pipes 20 through a rotary joint 27 arranged at the shaft 28 of rotor 14. In special cases, when whishing to influence the progress of dilution, the dilution lines 22 can be grouped into groups, having separately controllable feeding flows.

Fig 2 represents section A-A of the screen in Fig 1 seen from above. It shows an arrangement of separate dilution water pipes 22, ending in nozzles 20, which in the represented embodiment are integrated into turbulence generating bumps 18. The nozzles can also be arranged independently of the bumps, preferably so, that the direction of the dilution water jet from the nozzles is essentially parallel or tangential to the screen plate cylinder 16.

Fig 2 also shows how the outlet pipes 24 are separated from the direct influence of pressure pulses from bumps 18 by the separation ring 25.

Figures 1 and 2 represent an embodiment of the invention, where every nozzle 20 has its own feeding pipe 22, without ramifications, designed for a continuous high flow speed.

The flow speed should be sufficient to prevent biological activity in the pipes and also prevent build-up of deposits. It is known that piping will remain clean by itself, if the flow passes the pipe wall with a sufficient speed, or at least about 3 meters per second and there are no sharp angles or dead spaces retarding the flow. It is also known that in such situations turbulence prevents the forming of fibre bundles.

Generally a speed of about 3 meters per second or more will thus be desired in the pipes of the present invention. However, if the number of pipes is very

large and the pipes are very small in diameter a speed rate below 3 meters per second may also be sufficient to keep the pipes clean. The present incvention is thus not bound to any exact speed rate in said pipes.

If the number of nozzles 20 is very large, it is difficult to install an individual feeding pipe 22 for every nozzle in rotor 14. In this case the nozzles can be grouped so, that the distribution between nozzles is made inside the rotor. The nozzles 20 are preferably shaped for feeding the dilution water locally at a high speed close to the screening surface.

Fig 3 represents an embodiment, where the parts and the used reference numbers correspond to those presented in Fig 1. The screen according to Fig 3 functions essentially in the same way as the screen according to Fig 1. However, the feeding pipes 22 and 26 leading to nozzles 20 and 20', respectively, are grouped together in the center of the rotor 14. The dilution water is lead directly from the dilution water lines 21 and 29, respectively, through rotary joint 27 to distribution pipes 22 and 26.

In the embodiment of Fig 3 the reject dilution water is fed to separate reject dilution nozzles 20' by the reject dilution water line 29 through rotary joint 27 and reject dilution pipes 26 going through the rotor shaft 28 and the rotor 14.

When the dilution water pipes have one or more ramifications, these have to be executed according to known technology, so that, by action of the flow, the ramification point is kept in such state of turbulence that deposition of dirt and forming of fibre bundles is avoided.

In a process according to the invention the suspension to be cleaned is kept in a consistency suitable for efficient screening by means of continuous dilution, until essentially all acceptable fibres have passed the screening plate cylinder 16 at the end of the screening zone 15. The reject which is retained by the screening drum has a tendency to thicken. Thus, a last dilution is made in the reject zone at the end of the screening zone by separate reject extracting water 29, whereby the consistency of the reject is brought to a level whereby it can be discharged through reject discharge 23 without risk for clogging or abrasion.

Figure 4 represents an forming process for a paper web, where the advantages

of a screen according to the invention, functioning efficiently in one single stage, are utilized particularly efficiently.

The process in question is explained in detail in copending Patent Application FI 922285, by the same inventor. In said papermaking process the paper stock is fed as a controlled flow as a suspension of about 3 to 5 % consistency. from stock preparation 124 to the short circulation of said papermaking process. The stock is first diluted to a consistency of about 0.5 to 1.5%, whereafter it is brought to a separator 122. A preferred separator is the cleaner described in copending Patent Application 922282, by the same inventor. Said cleaner functions in a single stage, without recycling of reject. In the separator backwater recycled free of air from the sheet forming part is used for dilution and washing of reject. The cleaned stock is then brought forward to a screen according to the present invention 121, where also recycled air free backwater is used as dilution water.

From the pressurized screen the stock is brought to the paper machine headbox 100, which is preferably done through a particular distribution piping 125. The distribution piping 125 consists of a multiple accept pipes of the screen 121, arranged so that they are of essentially equal length, and further so that the number and curvature of eventual sharp bends are essentially identical for all pipes. With this arrangement, a uniform distribution of stock across the whole width of the paper machine can be granted.

From the headbox 100 the stock is fed to a sheet forming part, which can be of different known types. During sheet forming the major part of the water contained in the fibre suspension is drained into separate draining boxes 101, 102, 103 in connection with the forming fabric or fabrics. The backwater, collected in the draining boxes is preferably recycled back into the main process flow as separate air free flows, without passing through open vessels, by means of multiple pumps of which at least a part are preferably air separating pumps 110, such as gas separation pumps according to copending Patent Application 922283, by same inventor.

According to the presented favorable process the backwater to be recycled is brought to the various dilution points of the short circulation as separate flows, so that the dilution water required by the screen, subject to the present invention, and by the cleaner preceding the same in the stock flow, flows directly to

the stock main flow, without tube ramifications or upstream recirculations.

In said process it is further preferred to return the backwater first drained through the forming fabric and containing the highest proportion of drained fibre material as close to the headbox as possible.

The single stage function, without feed back of reject and without recycling of backwater or fibre suspension essentially accelerates reaching of a new state of equilibrium in connection with a change of paper grade or process adjustment, and thus considerably reduces the amount of waste paper produced at a grade change and improves the process controllability.

A person skilled in the art will realize that although the screen according to the present invention will provide the greatest advantages when used in connection with a direct flow papermaking process as described above, the advantages of the present screen may be used in many other ways within the scope and spirit of the appended claims.

Claims

1. A pressurized screen for the screening of a fibre suspension comprising a housing (12) and a perforated screen plate cylinder (16) inside said housing and a rotor (14) inside said screen plate cylinder (16), whereby between said screen plate cylinder (16) and said rotor (14) a reject-retaining screening zone (15) is formed and between said screen plate cylinder (16) and said housing (12) an accept-receiving accept chamber (17) is formed, said rotor (14) comprising means for conducting dilution water into said suspension, c h a r a c t e r i z e d in that said means for conducting dilution water in said rotor (14) comprises dilution water piping leading directly from an inlet (21) outside said housing (12) via numerous dilution water pipes (22) to a multiple of dilution water nozzles (20) rotating with the rotor (14) and opening close to the screening surface of said screen plate cylinder (16).

2. A pressurized screen according to claim 1 wherein the number of dilution pipes (22) is 5 to 100.

3. A pressurized screen according to claim 1 wherein the nozzles (20) are shaped for feeding the dilution water locally at a high speed close to said screening surface.

4. A pressurized screen according to claim 1 wherein said nozzles (20) are attached in connection with turbulence generating means (18) at the surface of said rotor (14).

5. A pressurized screen according to any one of the preceding claims wherein separate dilution water pipes (22) lead to separate nozzles (20) or groups of nozzles through said rotor (14).

6. A pressurized screen according to claim 1 wherein said nozzles (20) fed by said water dilution pipes (22) are placed mainly at the second half, preferably at the last third of said screening zone (15).

7. A pressurized screen according to any one of the preceding claims wherein said housing (12) and said rotor (14) or said screen plate cylinder (16) are slightly conical, so that the section of said screening zone (15) is larger at the

inlet end and said accept chamber (17) is larger at the outlet end, whereby a relatively high, and essentially constant axial flow speed can be maintained throughout the screen.

8. A pressurized screen according to claim 1 wherein a dilution pipe (29) leads dilution water to the outlet end of said screen plate cylinder (16).

9. A process for the cleaning of a fibre suspension in a pressurized screen, wherein said suspension is diluted during the screening process by water fed through a rotor rotating inside a screen plate cylinder, c h a r a c t e r i z e d in that said dilution water is led from outside said screen directly via numerous pipes in said rotor to the screening zone of said screen as locally directed flows generating turbulence close to the screening surface of said screen.

10. A process according to claim 9 wherein said dilution water is fed at high flow speed through multiple nozzles opening close to said screening surface.

11. A process according to claim 10 wherein the dilution water is fed through separate pipes in said rotor at a continuous flow having a speed sufficient to prevent deposits in said pipes.

12. In the short circulation of a papermaking process the improvement comprising circulating backwater as an essentially air free flow directly from a forming fabric to the dilution water inlet of a pressurized screen according to any one of the preceding claims 1 to 9.

13. The improvement according to claim 12 wherein the accept from said screen is fed into a headbox immediately downstream thereof through a distribution piping having multiple accept pipes of essentially identical length and flow resistance.

Fig 1

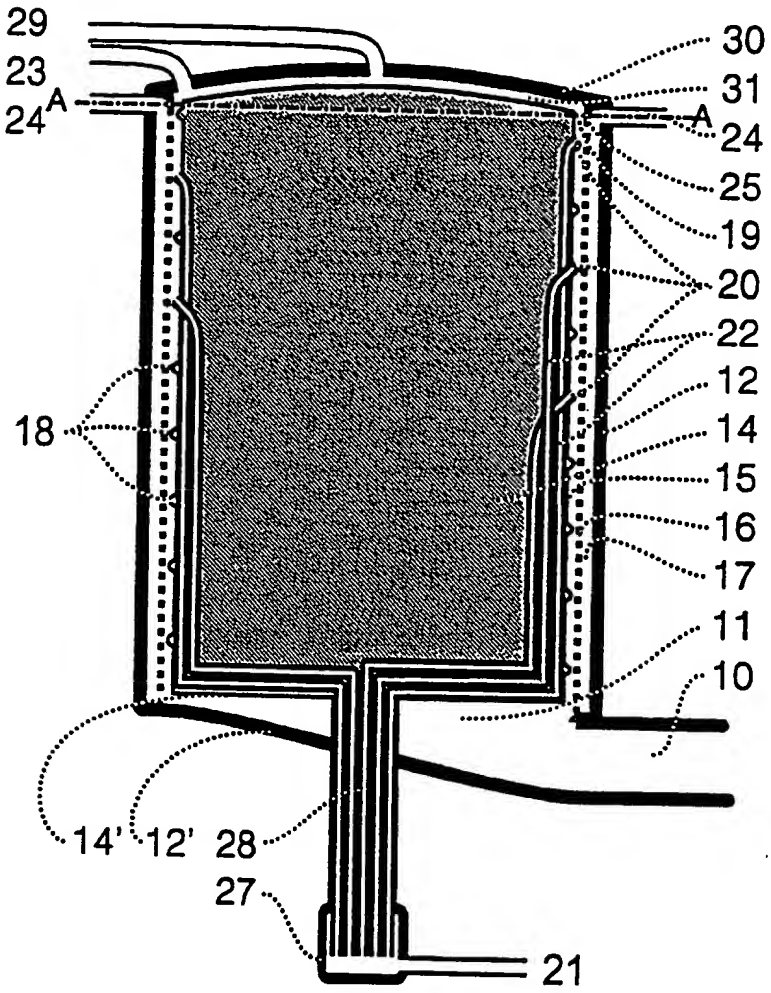
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Fig 2

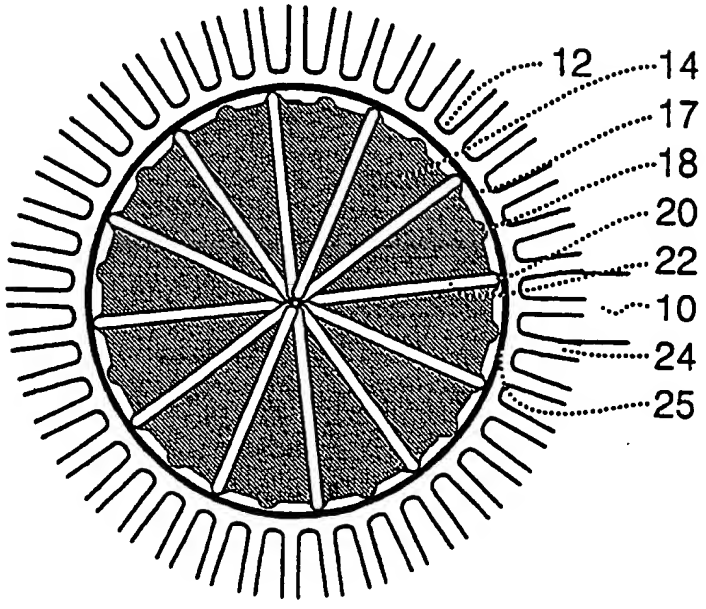
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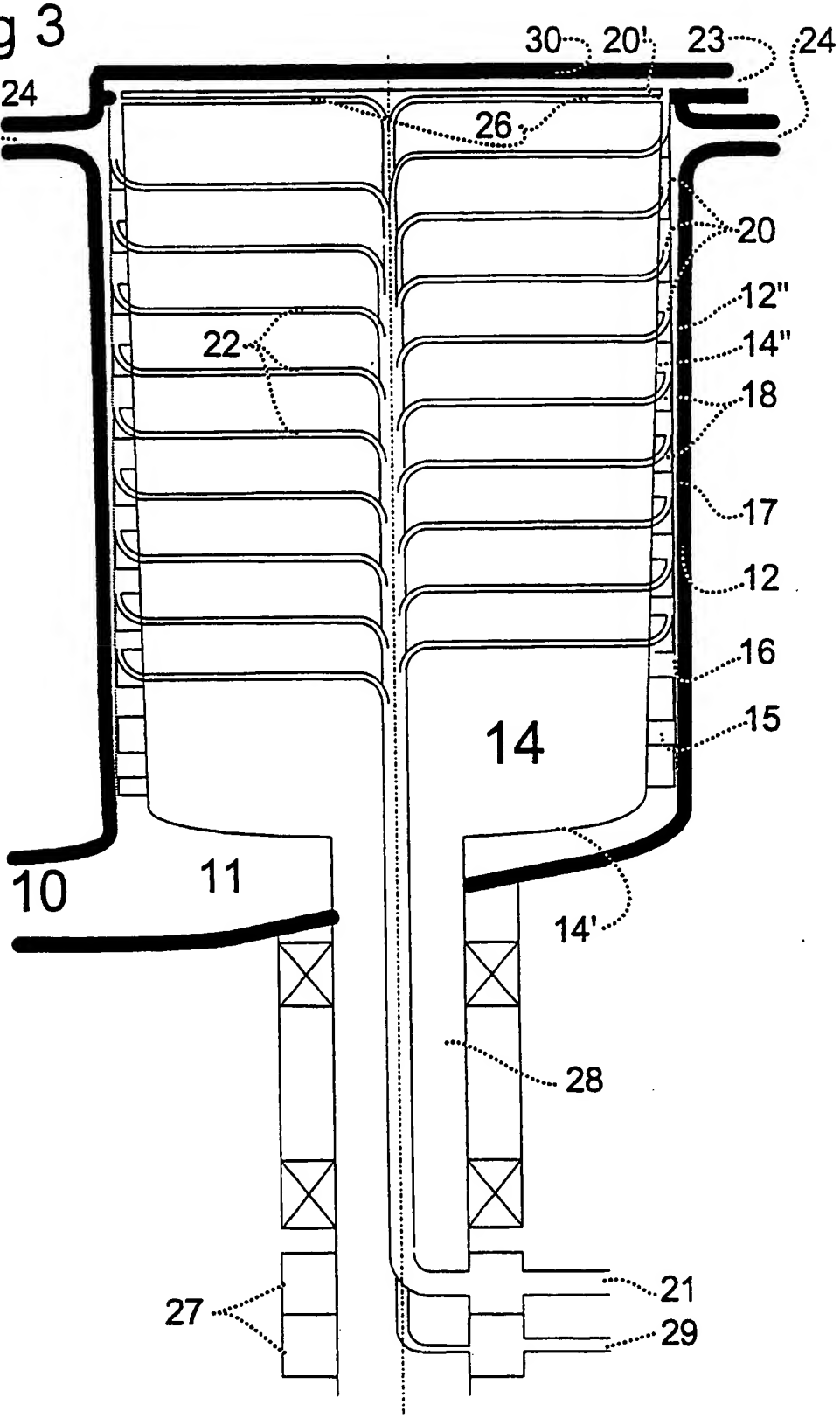
Fig 3



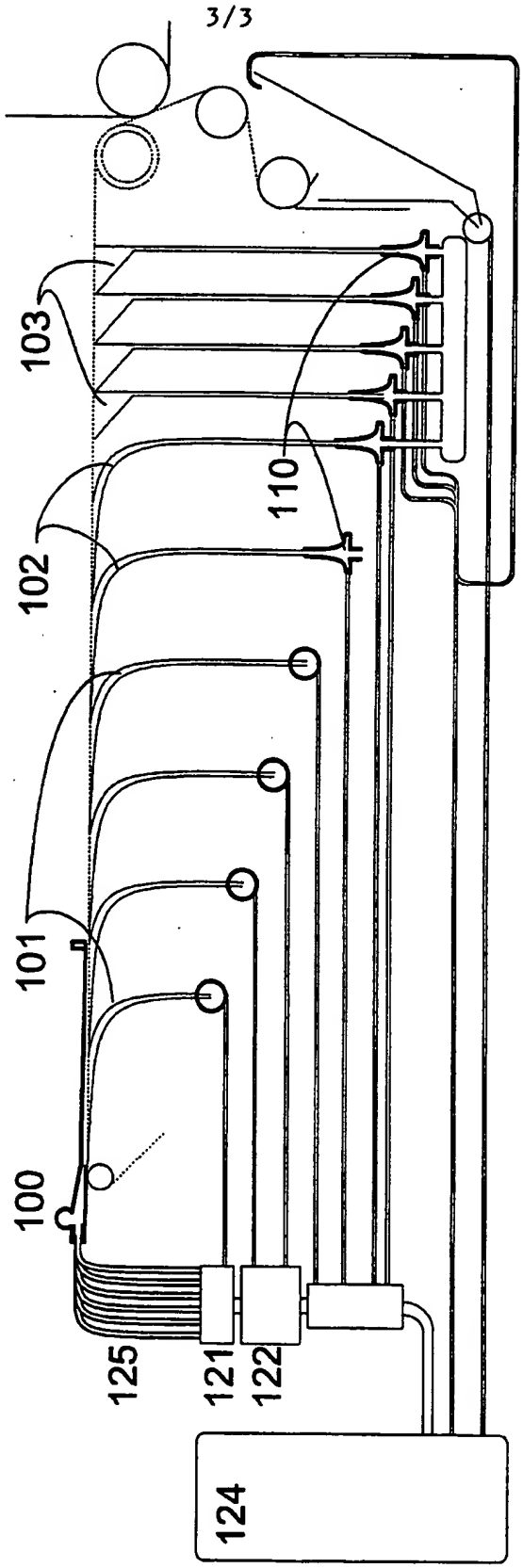


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 93/00213

A. CLASSIFICATION OF SUBJECT MATTER

IPC5: D21D 5/02
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC5: D21D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EDOC, WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FR, A1, 2666598 (SULZER-ESCHER WYSS GMBH), 13 March 1992 (13.03.92), page 8, line 30 - line 34; page 14, line 30 - line 33; page 15, line 4 - line 10, figures 5,6,8,10	1-4,7,9-11
Y	--	8
X	CA, A, 1007576 (S.W. HOOPER & CO. LTD.), 29 March 1977 (29.03.77), page 6, line 1 - line 9, figure 1	1-4
	--	
Y	US, A, 4749474 (DOUGLAS L.G. YOUNG), 7 June 1988 (07.06.88), column 3, line 1 - line 18, figure 1	8
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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 August 1993	02 -09- 1993
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Jan Carlerud Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 93/00213

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US, A, 4202761 (EMIL HOLZ), 13 May 1980 (13.05.80), column 5, line 37 - column 6, line 11	1

INTERNATIONAL SEARCH REPORT
Information on patent family members

30/07/93

International application No.
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